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(54) INSPECTING AND ANALYZING METHOD AND SAMPLE MANUFACTURING APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a new inspecting and analyzing method and an electronic component manufacturing apparatus for not bringing about a fault, even when a wafer taken out from a sample for an inspection is returned to a process for the inspection without wastefully discarding a substrate for its evaluation.

SOLUTION: The inspecting and analyzing method comprises the steps of emitting a second ion beam to an area including at least a region radiated by a first ion beam on the substrate, and removing at least a part of a surface of the sample containing a first ion beam element seed. Thus, in order to improve the yield of a semiconductor device or the like, the inspection on the way can be executed without dividing the wafer. Even in this case, reduction in contamination including the element seed for constituting the beam or a contamination including the element seed for constituting a deposit film can be realized.

CLAIMS

[Claim(s)]

[Claim 1] The inspection / analysis approach of the substrate characterized by to remove a part of sample front face [at least] where the 1st field was irradiated by the first ion beam

containing two or more elements in a substrate top, the second ion beam which consists the 2nd field which includes the 1st field of the exposure backward above by said first ion beam of a different element from base of two or more yuan of said first ion beam was irradiated, and the first ion beam element kind was included.

[Claim 2] After the processing process of the arbitration of a process which manufactures a circuit pattern to a substrate, the first ion beam is irradiated at said substrate. After the process which processes a substrate front face, and inspects or analyzes the processing section, or said processing process It has the process which separates said some of substrates using the first ion beam exposure at least. Then, the second ion beam is irradiated to the field which included at least the field where the first ion beam was irradiated on the substrate. The electronic-parts manufacture approach characterized by returning said substrate to said process which manufactures a circuit pattern, and carrying out second processing to it after passing through the process which removes a part of sample front face [at least] where the first ion beam element kind was included.

[Claim 3] The inspection / analysis approach of the substrate which carries out a laser beam exposure to the field which included at least the field where the ion beam was irradiated on the substrate, and is characterized by removing a part of sample front face [at least] where the ion beam element kind was included.

[Claim 4] In the sample production equipment which divides some substrates into the sample stage where holds a substrate and it can move, and the location of a request of a substrate by the processing approach using irradiating the ion beam containing a gallium at least, and produces a micro sample Sample production equipment characterized by having laser beam equipment which a laser beam is irradiated in the part which irradiated the ion beam, and can remove a part of sample front face [at least] where the ion beam element kind was included.

[Claim 5] Some substrates are divided into the sample stage where holds a substrate and it can move, and the location of a request of a substrate by the processing approach using irradiating the first ion beam containing a gallium at least. It has the ion beam control unit which records the field which irradiated the gallium ion beam, and exposure conditions in the sample production equipment which produces a micro sample. Based on this record, an ion beam control device irradiates the second ion beam which contains an argon, nitrogen, or oxygen at least to the field which irradiated the gallium ion beam. Sample production equipment characterized by being the ion beam control unit controlled to remove the sample front face which had the gallium contained.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the sample production equipment for realizing the inspection / analysis approach of electronic parts, such as a semiconductor device, the electronic-parts manufacture approach, and the this inspection / analysis approach.

[0002]

[Description of the Prior Art] High yield manufacture is called for in manufacture of electronic parts, such as semiconductor devices, such as semiconductor memory represented by dynamic random access memory, and a microprocessor, semiconductor laser, and the magnetic head. That is, lowering of the product yield by defect generating causes aggravation of profit. For this reason, early detection and an early cure the defect leading to a defect, and a foreign matter and poor processing serve as a big technical problem. For example, it is concentrated on by the defect discovery by careful inspection, and the analysis of the cause of generating in the manufacture site of a semiconductor device. According to the actual electronic-parts production process using a wafer, the wafer after completion is inspected, the cause of abnormality parts, such as a defect, a foreign matter, etc. of a circuit pattern, is investigated, and the cure approach is examined.

[0003]

[Problem(s) to be Solved by the Invention] In order to have managed efficiently so that a defective might not be taken out about manufacture of the above electronic parts, the following technical problems which should be solved were left behind.

[0004] usually -- although the scanning electron microscope (the following, SEM, and brief sketch) of a high resolution uses for fine structure observation of a sample -- high integration of a semi-conductor -- following -- an object -- the resolution of SEM -- being unobservable -- becoming -- **** -- SEM -- replacing -- observation -- a transmission electron microscope (the following, TEM, and brief sketch) with high resolution is used.

[0005] The activity which makes a sample a wafer by cleavage, cutting, etc. followed on the conventional TEM sample production, and in almost all cases, the wafer had to be ****(ed) when a sample was a wafer.

[0006] Recently, an ion beam is irradiated at a sample and there is the processing approach to which the particle which constitutes a sample according to a spatter operation applied the operation emitted from a sample, i.e., the example using focused ion beam (it abbreviates to FIB hereafter) processing. This starts a submillimeter meter strip-of-paper-like pellet including the field which should be first observed from samples, such as a wafer, using dicing equipment etc. Next, carry out FIB processing and let a part of this strip-of-paper-like pellet be a TEM sample at the shape of a thin wall. Some test pieces have the description of the sample for TEM observation by which FIB processing was carried out here in having processed the thin film whose thickness is about 100nm for

TEM observation. although it became possible to carry out location appearance and to observe by carrying out the desired observation section in the precision of micrometer level by this approach, a wafer must be ****(ed) too.

[0007] Thus, although it is in the middle of manufacture of a semiconductor device etc. and the advantage of supervising the result of a certain process is large on yield management, in sample production which was already described, a wafer is ****(ed), and the fragment of a wafer is discarded, without progressing to the following process. In recent years, in order that especially a wafer may lower the manufacture unit price of a semiconductor device, diameter-ization of macrostomia is progressing. That is, the number of the semiconductor device which can be manufactured with one wafer is increased, and a unit price is reduced. However, a wafer becomes expensive at reverse and the number of the semiconductor device further lost by destruction of a wafer also increases. Therefore, the inspection approach which includes fragmentation of the conventional wafer was dramatically uneconomical.

[0008] On the other hand, there is the approach of carrying out sample production, without dividing a wafer. As for this approach, "analytical method of the separation sample obtained by the separation approach of a sample and this separation approach" is indicated by JP,05-52721,A. As shown in drawing 2 , first, this approach maintains the position of a sample 2 so that FIB1 may irradiate a right angle to the front face of a sample 2, it makes a rectangle scan FIB1 on a sample, and forms the angle hole 101 of the necessary depth in a sample front face (drawing 3 (a)). Next, a sample 2 is made to incline and a bottom opening 102 is formed. A change of the tilt angle of a sample 2 is made by the sample stage (not shown) (drawing 3 (b)). The position of a sample 2 is changed, a sample 2 is installed so that the front face of a sample 2 may become vertical again to FIB1, and the notching slot 103 is formed (drawing 2 (c)). A manipulator (not shown) is driven and the head of the probe 3 at the head of a manipulator is contacted into the part which separates a sample 2 (drawing 3 (d)). deposition nature gas 5 is supplied from a gas nozzle 104 -- FIB1 is locally irradiated to the field containing the point of a probe 3, and the ion beam assistant deposition film (it abbreviates to the depository film 4 hereafter) is formed. The leaver section of a sample 2 and the head of a probe 3 in a contact condition are connected by the depository film 4 (drawing 3 (e)). Notching processing of the part remaining by FIB1 is carried out (drawing 3 (f)), and the micro sample 6 which is a separation sample is started from a sample 2. It will be supported with the connected probe 3 by the started separation sample 6 (drawing 3 (g)). This micro sample 6 is processed by FIB1, and if Wall processing of the field which it is going to observe is carried out, it will become a TEM sample (not shown). It is the approach of separating a minute test piece including a desired analysis field from samples, such as a wafer, making full use of the conveyance means of FIB processing and a minute sample. The minute sample separated by this approach is

analyzable by introducing into various analysis equipments. It also becomes possible from a sample for ejection and a wafer to return a checking minute sample to the following process, without dividing a wafer, if this technique is used. Therefore, the semiconductor device lost by fragmentation of a wafer like before is lost, and can reduce the manufacturing cost of a total semiconductor device.

[0009] However, by this technique, since FIB is used when separating a minute sample, the element kind which constituted FIB remains in the processing field which took out the minute sample. Moreover, some fragments of the element kind which constituted FIB according to the spatter operation by FIB exposure besides the FIB processing field, or a sample disperse. Moreover, in using the depository film, the element kind which constitutes deposition gas remains on a processing field or the outskirts of it. Existence of these element kind has high possibility of becoming a defect generating cause, for semiconductor device manufacture. That is, when these contamination was left as it was and the wafer was returned to the following process, these element kinds were spread, it invaded into the semiconductor device which had passed through the manufacture process normally, and there was a problem of generating poor electrical characteristics and poor contact. It is possible to perform washing using a chemistry drug solution to the wafer which took out the minute sample as this cure. However, there was also a serious problem [contamination / including the ion beam element kind which is carrying out incidence of a sample front face to a depth of about 10nm to the interior when / that there was a problem that a routing counter increased and a manufacturing cost became high / FIB is further irradiated for example, by 30kV acceleration, and was embedded into the sample in surface washing] that clearance was completely impossible.

[0010] Establishment of the technique to which cost removes contamination including the element kind which could carry out, without an intermediate inspection ****(ing) a wafer, and constituted the ion beam also on that occasion for improvement in a yield, such as a semiconductor device, since it was such, and contamination including the element kind which constitutes the depository film simple at a low price, and the technique of the ability to be also able to remove the field where FIB was embedded simple, and development of the equipment which can realize it were desired.

[0011] Even if the 1st object of this application returns to a process the wafer which did not discard vainly because of assessment of a substrate, and took out the sample for inspection, it is in view of an above-mentioned trouble to offer the new inspection / analysis approach of not generating a defect, and the electronic-parts manufacture approach, and it is in the second object offering the sample production equipment for attaining the 1st object of the above.

[0012]

[Means for Solving the Problem] The first object which was described above is attained by

performing it as follows.

[0013] (1) Irradiate the first ion beam, process a substrate front face into a substrate, and inspect or analyze the processing section, or separate some substrates by the processing approach using the first ion beam exposure at least. In the inspection / analysis approach of a substrate of inspecting and analyzing the separated micro sample The second ion beam is irradiated to the field which included at least the field where the first ion beam was irradiated on the substrate, and it considers as the inspection / analysis approach of the substrate characterized by removing a part of sample front face [at least] where the first ion beam element kind was included.

[0014] According to the inspection / analysis approach of this means, a new defect is not generated even if it returns to a process the substrate which did not discard vainly because of assessment of a substrate, and started the sample for inspection.

[0015] (2) Irradiate the first ion beam after the processing process of the arbitration of a process which manufactures a circuit pattern to a substrate. After the process which processes a substrate front face, and inspects or analyzes the processing section, or said processing process It has the process which separates some substrates using the first ion beam exposure at least. Then, the second ion beam is irradiated to the field which included at least the field where the first ion beam was irradiated on the substrate. After passing through the process which removes a part of sample front face [at least] where the first ion beam element kind was included, it considers as the electronic-parts manufacture approach characterized by returning said substrate to said process which manufactures a circuit pattern, and carrying out second processing to it.

[0016] According to the electronic-parts manufacture approach of this means, a new defect is not generated even if it returns to a process the substrate which did not discard vainly because of assessment of a substrate, and started the sample for inspection. As a result, the manufacture yield of electronic parts improves.

[0017] (3) Irradiate an ion beam, process a substrate front face into a substrate, and inspect or analyze the processing section, or separate some substrates by the processing approach using an ion beam exposure at least. In the inspection / analysis approach of a substrate of inspecting and analyzing the separated micro sample A laser beam exposure is carried out to the field which included at least the field where the ion beam was irradiated on the substrate, and it considers as the inspection / analysis approach of the substrate characterized by removing a part of sample front face [at least] where the ion beam element kind was included.

[0018] According to the inspection / analysis approach of this means, a new defect is not generated even if it returns to a process the substrate which did not discard vainly because of assessment of a substrate, and started the sample for inspection.

[0019] (4) Irradiate an ion beam after the processing process of the arbitration of a process

which manufactures a circuit pattern to a substrate. After the process which processes a substrate front face, and inspects or analyzes the processing section, or said processing process It has the process which separates some substrates using an ion beam exposure at least. Then, the laser beam exposure of the field where the ion beam was irradiated on the substrate is carried out to the field included at least. After passing through the process which removes a part of sample front face [at least] where the ion beam element kind was included, it considers as the electronic-parts manufacture approach characterized by returning said substrate to said process which manufactures a circuit pattern, and carrying out second processing to it.

[0020] According to the inspection / analysis approach of this means, a new defect is not generated even if it returns to a process the substrate which did not discard vainly because of assessment of a substrate, and started the sample for inspection. As a result, the manufacture yield of electronic parts improves.

[0021] (5) Irradiate an ion beam, process a substrate front face into a substrate, and inspect or analyze the processing section. In the inspection / analysis approach of a substrate of separating some substrates by the processing approach using an ion beam exposure at least, and inspecting and analyzing the separated micro sample Before irradiating an ion beam at a substrate, some substrates [at least] are covered with a thin film, a substrate front face is processed by the processing approach including next irradiating an ion beam from on a thin film, and it considers as the inspection / analysis approach of the substrate characterized by removing said thin film after processing.

[0022] According to the electronic-parts manufacture approach of this means, it is not necessary to discard vainly because of assessment of a substrate. And a new defect is not generated even if it returns the substrate which started the sample for inspection to a process.

[0023] (6) After the processing process of the arbitration of a process which manufactures a circuit pattern to a substrate, cover some substrates [at least] with a thin film, and then irradiate an ion beam from on a thin film. After the process which processes a substrate front face, and inspects or analyzes the processing section, or said processing process Cover some substrates [at least] with a thin film, and it has the process which separates some substrates by the processing approach including next irradiating an ion beam from on a thin film. Then, after passing through the process which removes said thin film, it considers as the electronic-parts manufacture approach characterized by returning said substrate to said process which manufactures a circuit pattern, and carrying out second processing to it.

[0024] According to the electronic-parts manufacture approach of this means, it is not necessary to discard vainly because of assessment of a substrate. And a new defect is not generated even if it returns the substrate which started the sample for inspection to a

process. As a result, the manufacture yield of electronic parts improves.

[0025] The sample stage where holds (7) substrates and it can move in order to attain the second object, In the sample production equipment which divides some substrates into the location of a request of a substrate by the processing approach using irradiating the ion beam containing a gallium at least, and produces a micro sample A laser beam is irradiated in the part which irradiated the ion beam, and it considers as the sample production equipment characterized by having laser beam equipment which can remove a part of sample front face [at least] where the ion beam element kind was included.

[0026] According to the sample production equipment of this means, even if it returns to a process the substrate which did not discard vainly because of assessment of a substrate, and started the sample for inspection, the inspection / analysis approach and the electronic-parts manufacture approach of not generating a new defect are realizable.

[0027] (8) Divide some substrates into the sample stage where holds a substrate and it can move, and the location of a request of a substrate by the processing approach using irradiating the first ion beam containing a gallium at least. It has the ion beam control unit which records the field which irradiated the gallium ion beam, and exposure conditions in the sample production equipment which produces a micro sample. Based on this record, an ion beam control device irradiates the second ion beam which contains an argon, nitrogen, or oxygen at least to the field which irradiated the gallium ion beam. It considers as the sample production equipment characterized by being the ion beam control unit controlled to remove the sample front face which had the gallium contained.

[0028] According to the sample production equipment of this means, even if it returns to a process the substrate which did not discard vainly because of assessment of a substrate, and started the sample for inspection, the inspection / analysis approach and the electronic-parts manufacture approach of not generating a new defect are realizable.

[0029] In either of the above (1) to (8) the (9) above-mentioned sample Moreover, a silicon semiconductor wafer, [whether they are an epitaxial growth silicon wafer, the wafer which has the SHIRIN thin film formed in the substrate, a compound semiconductor wafer, or the magnetic-head accumulation wafers, and] The (10) above-mentioned electronic parts Or a silicon semiconductor device, a compound semiconductor device, [whether they are either the head for magnetic-recording playback or the heads for magneto-optic-recording playback, and] (11) Inside [it is a transmission electron microscope, a scanning transmission electron microscope, a scanning electron microscope or a scanning probe microscope] at least the above-mentioned inspection, using either the (12) above-mentioned analysis Even if there are few electron beams, ion beams, and X-rays, elemental analysis is carried out using either. [as compared with any it judges right / poor / at least among element distribution or element concentration of the criteria defined beforehand, impurity distribution, and high impurity concentration, and] Or the

configuration of the criteria beforehand defined about the part which defined the (13) above-mentioned analysis beforehand. The data which solved a dimension, element distribution, element concentration, impurity distribution, and the cause of having separated from either at least among high impurity concentration, or were obtained in the process of the (14) above-mentioned monitor, inspection, or the analyses which performs either at least are saved at least at a computation machine.

[0030]

[Embodiment of the Invention] The example of a gestalt of operation of the electronic-parts manufacture approach by this application In the electronic-parts manufacture approach which gives two or more processing processes to a sample, and forms electronic parts As opposed to the part which extracts the part which includes the substrate front face of the above-mentioned sample in a processing process, and includes the above-mentioned substrate front face progress of processing in the above-mentioned processing process The process of a monitor, inspection, or the analyses which performs either at least, It is in the approach of returning a substrate to a processing process further and manufacturing a circuit pattern, after removing a part including a substrate front face.

[0031] The flow of a wafer is explained for the fundamental flow of the electronic-parts manufacture approach by <example 1 of operation gestalt> this application using drawing 1 .

[0032] The lot 13 which consists of two or more wafers first is thrown into the Nth process 11 of arbitration. Next, the checking wafer 14 is sorted out among two or more wafers, and the left-behind wafer stands by. The checking wafer 14 sorted out is first introduced into the inspection electron microscope 15. When abnormalities are discovered here, the location is recorded and the information is sent to sample production equipment 17. this -- a sample -- production -- equipment -- 17 -- checking -- a wafer -- 14 -- from -- it should inspect -- a part -- containing -- a micro -- a sample -- six -- a gallium -- FIB -- one -- a manipulator -- a head -- having attached -- a probe -- three -- and -- DEPOGASU -- W -- (-- CO --) -- six -- having produced -- a depository -- the film -- etc. -- using -- extracting . The checking wafer 14 which had the micro sample 6 extracted is built into the lot 13 left behind the account of a top again, and is thrown into the N+1st following processes 12. Here, the micro sample 6 analyzes about delivery and the inspection item defined beforehand to analysis equipment 18. Thus, while resulting [from the Nth process] in the N+1st processes, it is the big description that the micro sample 6 for analysis is extracted. Moreover, although a semiconductor device including the processing field which extracted the micro sample 6 becomes invalid [the process of the N+1st henceforth] and does not serve as a product by inspection, wafer number of sheets does not decrease. That is, the number of wafers supplied to the wafer thrown into the Nth process and the N+1st processes is the same, and if the semiconductor device manufactured except the field where

the micro sample 6 was taken out is an excellent article, it will contribute to the number of manufactures as a product.

[0033] However, by this technique, when separating a minute sample, the contamination which contains a gallium since Gallium FIB is used occurs on the processing field which took out the minute sample, or the outskirts of it. Moreover, in order to use the depository film, contamination containing a tungsten, carbon, etc. occurs.

[0034] Then, a gallium carries out a laser beam exposure to the field irradiated by the wafer within sample production equipment equipped with laser beam irradiation equipment, and the sample part containing a gallium is removed. In addition, detail of sample production equipment 17 equipped with laser beam irradiation equipment is given in detail later.

[0035] The laser used here should just have sufficient output to fuse a sample and evaporate it for a short time. For example, excimer laser, an YAG laser, carbon dioxide gas laser, dye laser, etc. are usable. The YAG laser was used in this example. this laser beam -- dramatically -- reinforcement -- it can be high and a sample front face can be evaporated. For example, to the detailed semiconductor device currently manufactured to the silicon wafer, with the laser beam control unit which inputted micro sample production conditions, it aims automatically and a laser beam is irradiated. Consequently, a field which contains a gallium is removed from a wafer front face. In addition, what is necessary is for the construction material on the front face of a sample which carries out a laser beam exposure just to adjust the wavelength of laser, and energy.

[0036] In addition, although ion beam equipment was equipped with the laser beam microscope which irradiates a laser beam at a sample, detects the light reflected from a sample, and observes a sample when a sample was observed conventionally, energy was low, removing a sample front face was hardly completed and the object of this invention was not able to be attained.

[0037] According to the electronic-parts manufacture approach of the gestalt this operation, it is not necessary to discard vainly because of assessment of a substrate. And a new defect is not generated even if it returns the substrate which started the sample for inspection to a process. As a result, the manufacture yield of electronic parts improves.

[0038] Although the sample production equipment incorporating laser equipment is performing in this example, after sample production, a wafer may be introduced into laser-beam-machining equipment with the engine performance equivalent to the above-mentioned laser equipment, and same clearance may be performed. In this case, processing positional information is transmitted to laser-beam-machining equipment 19 from sample production equipment 17, and it can be made to carry out to a processing location automatic laser radiation of it. However, the cost of two equipments is required in this case, working hours also become long and the economical cost which starts device

manufacture as a result becomes high.

[0039] The outline block diagram of sample production equipment equipped with the laser beam irradiation equipment which is one example by <example 2 of operation gestalt> this application is shown in drawing 3 .

[0040] Sample production equipment 17 has the vacuum housing 41. In a vacuum housing By the FIB exposure optical system 35 and the FIB exposure which consist of the liquid metal ion source 32 which emits a gallium, beam limit aperture 33, an ion-beam-scanning electrode 34, an ion beam lens 31, etc. The secondary electron and secondary ion which are emitted from a sample To the aggregated particle detector 36 and ion beam exposure field to detect, the depository film The former ingredient gas for forming The sample stage 39 in which the sample substrates 38, such as the source 37 of DEPOGASU to supply, the probe 3 attached at manipulator 42 head, a semiconductor wafer, and a semiconductor chip, are laid, the sample holder 40 which fixes the minute extraction sample which extracted some sample substrates are arranged. Moreover, it is equipped with the laser equipment 56 which consists of a laser generating oscillator 51, laser amplifier 52, a second harmonic generation machine 53, etc. and the laser reflecting mirror 54 which leads a laser beam to a sample processing location, and the optical lens 55 grade for laser. These laser equipments 56, the laser reflecting mirror 54, and the optical lens 55 grade for laser are summarized as one component, and are being fixed to the vacuum housing. In addition, as equipment which controls this equipment, the stage control device 61 which mainly consists of an electrical circuit or an arithmetic unit, the manipulator control device 62, the amplifier 63 of a secondary electron detector, the source control device 64 of DEPOGASU, the FIB control device 65, the laser reflecting mirror positional controller 71, the optical lens control device 72 for laser, the laser control device 73, computation equipment 74, etc. are arranged.

[0041] Next, actuation of this sample production equipment is explained. First, the ion emitted from the liquid metal ion source 32 is irradiated through the beam limit aperture 33 and the ion beam lens 31 at the sample substrate 38. FIB1 is formed into a thin bundle by about 1 micrometer from the diameter of several nanometers on a sample. If FIB1 is irradiated at the sample substrate 38, the configuration atom on the front face of a sample will be emitted by the sputtering phenomenon into a vacuum. Therefore, by making FIB1 scan using the ion-beam-scanning electrode 34, processing of submicrometer level can be performed from the micrometer. Moreover, the depository film can be formed by irradiating FIB1 at the sample substrate 38, introducing deposition gas all over a sample room. Thus, the sample substrate 38 is processible, using sputtering or deposition by FIB1 skillfully. Since the contact section and the sample which exist at the head of a probe 3 are connected or an extraction sample is fixed to the sample holder 40, the depository film formed by FIB1 exposure is used. Moreover, FIB1 can be scanned, the aggregated particle detector 36

can detect the secondary electron and secondary ion which are emitted from a sample, and the sample substrate 38, a probe 3, etc. can be observed by changing the reinforcement into the brightness of an image.

[0042] About the processing actuation for micro sample production using a gallium FIB 1, it is the same as the conventional approach. And the micro sample 6 analyzes delivery and the cross-section fine structure to a transmission electron microscope. The laser beam exposure actuation after micro sample production is explained below. Here, an YAG laser is used as a laser generator. First, with the laser reflecting mirror 53, the laser beam 57 emitted from the laser generator 56 can change the direction, and is drawn in a vacuum housing towards a processing field through the optical lens 54 for laser. The laser used here has sufficient output to fuse a sample and evaporate it for a short time. This laser is pulse oscillation laser and was set as the pulse width for about 6ns, the wavelength of 532nm, and pulse energy abbreviation 5mJ. If this laser is irradiated at a sample, the configuration atom on the front face of a sample will be emitted by melting, the evaporation phenomenon, etc. into a vacuum. Moreover, a laser beam radiation scar is beforehand scanned by FIB1, the aggregated particle detector 36 detects the secondary electron emitted from a sample, and if physical relationship of a laser beam exposure field and an ion beam exposure field is clarified, the automatic exposure of the laser beam 57 can be carried out to the processing field 42 by observing a laser beam radiation scar, for example to the detailed semiconductor device currently manufactured to the silicon wafer based on processing positional information. In this example, one side which irradiates a laser pulse 10 times and includes a processing field was able to remove dozens of micrometer field a depth of several micrometers. These control is performed by unifying with computation equipment 74. Next, although the sample substrate 38 is thrown into the following process, it can remove a gallium and deposition gas constituents by laser radiation processing, and does not cause a defect in subsequent processes.

[0043] According to the gestalt of this operation, even if it returns to a process the wafer which did not consume a substrate vainly because of assessment, and started the sample for inspection, the sample production equipment which can realize the electronic-parts manufacture approach of not generating a new defect is offered.

[0044] The sample production equipment which is another operation gestalt which is similar to drawing 4 at this example is shown. A laser beam exposure is carried out after micro sample production also with this sample production equipment. Here, unlike the gestalt of the above-mentioned implementation, the laser generator 56 is not being fixed to the vacuum housing. With this equipment, excimer laser comparatively large-sized as laser can be used. The laser beam 57 emitted from the laser generator 56 is similarly drawn in a vacuum housing towards a processing field through the optical lens 54 for laser which could change that direction with the laser reflecting mirror 53 placed into

atmospheric air, and was further placed into atmospheric air with this equipment. If laser is irradiated at a sample, the sample up layer which includes a processing field according to melting, an evaporation phenomenon, etc. is removable. This control is performed by unifying with computation equipment 74 similarly. This example can also remove a gallium and deposition gas constituents by laser radiation processing, and does not cause a defect in subsequent processes.

[0045] The outline block diagram of sample production equipment equipped with the 2nd ion beam irradiation equipment which is one example by <example 3 of operation gestalt> this application is shown in drawing 5.

[0046] This sample production equipment 17 has the vacuum housing 41, and the configuration of the FIB exposure optical system 35, the aggregated particle detector 36, the source 37 of DEPOGASU(deposition gas), a probe 3, and sample stage 39 grade of it is the same as that of the sample production equipment of the example 2 of an operation gestalt in a vacuum housing. With this equipment, the second ion beam illuminating system which consists of the duo plasmatron 81 which emits gas ion, such as argon, oxygen, and nitrogen, an ion beam lens 82, beam limit aperture 83, an ion-beam-scanning electrode 84, etc. is installed. Moreover, as equipment which controls this equipment, the duo-plasmatron control device 91, the optical-system control device 92, the ion scan control device 93, computation equipment 74, etc. are arranged other than the stage control device 61, the manipulator control device 62, the amplifier 63 of a secondary electron detector, the source control device 64 of DEPOGASU, and the FIB control device 65.

[0047] Actuation of the FIB exposure optical system 35 is the same as that of the gestalt 2 of operation, and is the same as the conventional approach also about the processing actuation for micro sample production using a gallium FIB 1. And the micro sample 6 extracted from this equipment is analyzed with test equipment.

[0048] The second ion beam exposure actuation after micro sample production is explained below. The ion source of the second ion beam irradiation equipment is a duo plasmatron 81, and irradiates argon ion here. The acceleration voltage of an ion beam 85 was 5kV, the ion current was adjusted to 2microampere and the beam diameter was adjusted to about 10 micrometers. Moreover, it becomes it is possible to aim at the location of the arbitration of the substrate sample 38 with the beam scan electrode 84, and possible to scan and irradiate the processing field 42 where the gallium was irradiated. For this purpose the following preparation is conducted beforehand. First, it converges in the shape of a spot, and the argon ion beam 85 is irradiated at a sample. Next, the relationship between the location irradiated by an argon ion beam and that irradiated by FIB1 are clarified by scanning the radiation scar of the shape of the spot by FIB1, detecting secondary electron, and observing spot-like irradiation scar. And to the ion-beam-scanning control unit 93 of this equipment, the processing location of the micro sample 6 and gallium FIB exposure

condition information are memorized, a processing location is called from this storage information, argon ion beam illuminating system is controlled, and the automatic exposure of the argon ion beam 85 is carried out in a processing location. Furthermore, a gallium dose can be calculated from gallium FIB exposure conditions, the conditions which remove most gallium altogether can be set up, and the automatic exposure of the argon ion beam 85 can be carried out. These controls are performed by unifying with computation equipment 74.

[0049] In addition, since an ion beam can irradiate a target position with a sufficient precision compared with the laser equipment stated in said example 2 of an operation gestalt and an ion beam is further excellent also in focusing nature compared with a laser beam, it is suitable for aiming at and removing detailed contamination. On the other hand, since a laser beam can evaporate a sample for a short time, it raises a throughput or is suitable for processing an extensive field at once.

[0050] In this example, the argon ion beam 85 was irradiated for 1 minute, and one side including a processing field was able to remove the about ten-micrometer field a depth of 2 micrometers. Next, although the sample substrate 38 is thrown into the following process, it can remove a gallium and deposition gas constituents by argon ion irradiation processing, and does not cause a defect in subsequent processes.

[0051] According to the gestalt of this operation, even if it returns to a process the wafer which did not consume a substrate vainly because of assessment, and started the sample for inspection, the sample production equipment which can realize the electronic-parts manufacture approach of not generating a new defect is offered.

[0052] In addition, with this equipment, although the second ion beam equipment is built into FIB ion beam equipment, the second ion beam irradiation equipment with the engine performance equivalent to the second above-mentioned ion beam irradiation equipment may perform clearance. In this case, processing positional information is transmitted to argon ion beam irradiation equipment from FIB ion beam equipment, and it can be made to carry out laser radiation of the processing location automatically. However, the cost of two equipments is required in this case, working hours also become long and the economical cost which starts device manufacture as a result becomes high.

[0053] Next, the example which reduces contamination by the ion beam element kind, i.e., a gallium, is explained using the <example 4 of an operation gestalt>, by use of the technique of covering at least a part of a substrate by a thin film.

[0054] In this technique, a thin film is formed on a wafer so that a processing field may be first covered before processing of a micro sample. as the approach of forming a thin film -- (1) -- organic system thin films, such as metal thin films, such as gold prepared beforehand and platinum, or an epoxy system resin thin film, and a polyimide thin film, are placed on a wafer. (2) Apply a liquid ingredient on a wafer and form a thin film by heating a wafer. (3)

Form a thin film by the chemical vacuum deposition which uses vacuum evaporation of a metal or carbon, the various thin film formation by the spatter, or composition of chemistry gas in vacuum devices.

[0055] In addition, the liquid ingredients used above (2) are various complex solutions (for example, they are the coating liquid for silicon oxide system coat formation (for example, metal complex solutions, such as coating liquid for silicon oxide system coat formation by TOKYO OHKA KOGYO CO., LTD., or Cr, Ti) called a spin-on glass (omitting SOG), an epoxy system resin solution, and a polyimide precursor solution.). Spreading can be performed using a spinner or various pipets. Next, protective coat formation from the applied liquid ingredient is performed by the photo-curing using baking which used heating means, such as various ambient atmosphere furnaces, a hot plate, and laser, and a UV irradiation means to irradiate an ultraviolet ray lamp and ultraviolet laser etc.

[0056] Next, the sample making process by this technique is described using drawing 6 . Drawing 6 (a) is drawing which started production of a micro sample by FIB1 with sample production equipment after forming a thin film 202 in the silicon wafer 201. Before this process, the coating liquid thin film for silicon oxide system coat formation called the spin-on glass (omitting SOG) which is a liquid ingredient on a wafer 201 was applied so that a processing schedule field might be covered at least. Next, on the hot plate, the spin-on glass was heated and the wafer was calcinated. Then, it introduced into sample production equipment. And as already stated, a micro sample is extracted from a wafer, making full use of the probe attached at FIB1 and the head of a manipulator, ion beam gas assistant deposition, etc. Drawing 6 (b) shows the sample cross section. This sample was prepared for the wiring process development of a semiconductor device, forms silicon oxide 203 on a silicon wafer 201, and forms the wiring 204 of Cu in the inside of it on a chain. However, the chain has run out within the circle 205. The analysis object of this sample is solving the cause of this open circuit. A silicon oxide 203 top is the thin film which calcinated and produced the spin-on glass. Although FIB1 is irradiated from a thin film at the time of sample production initiation, by sputtering, a hole will get bored with a thin film and an ion beam will reach a sample. Drawing 6 (c) shows signs that leave the target open-circuit section and hole processing is carried out by FIB1 from both sides. As shown in this drawing, the deposit 206 containing a part of gallium and sample exists in the sample top face around a processing field. Moreover, the minute particle generated from some matter borne by deposition gas besides some fragments of a gallium or a sample or the component part of sample equipment may fall on a thin film. Each of these is the pollutants which may cause a defect for a semi-conductor manufacture process. However, that of these will remain on a thin film, without reaching a substrate. About subsequent micro sample production procedures, it is the same as the conventional approach. At the following process, after extracting a micro sample, ejection and a thin film are removed for

a substrate. The etching system using the plasma was used as an approach of removing a thin film. Thereby, the minute particle which dispersed in addition to the ion beam machining field and which is generated from the component part of the matter borne by the gallium or deposition gas and sample equipment is removable at once at least with ion beam machining. In addition, it is removable by the approach stated with the operation gestalt 1 of invention, or the operation gestalt 2 of invention, i.e., the second ion beam exposure, and the laser beam, the ion beam, i.e., the gallium, left behind to the processing field.

[0057] In addition, the thin film clearance approach changes with classes of thin film formed in the wafer. For example, what is necessary is just to remove a thin film, when (1) **** is placed on a substrate. Moreover, as shown in (2) and (3), when a thin film is formed on a substrate, an ashing device removes, the dry etching using the plasma etc. removes, or an organic solvent melts and removes.

[0058] According to the electronic-parts manufacture approach of the gestalt this operation, it is not necessary to discard vainly because of assessment of a substrate. And a new defect is not generated even if it returns the substrate which started the sample for inspection to a process. As a result, the manufacture yield of electronic parts improves. In addition, although the example of the gestalt of the operation described above described the example which adopted the approach of taking out a micro sample with sample production equipment, with sample production equipment, the configuration of a micro sample may be processed, a substrate may be picked out from sample production equipment, and a micro sample may be taken out by another device. For example, as shown in drawing 7 (a), a thin film 208 is formed on a wafer, the both sides of a target position are processed by FIB1 stair-like, the cross-section sample thin film 207 is produced, as shown in drawing 7 (b), the sample thin film circumference is cut off by FIB1, and the sample thin film 207 is cut from a wafer. And a wafer is picked out from sample production equipment and the sample thin film 207 is moved to the TEM sample holder 209 from a wafer in atmospheric air using static electricity of a glass rod. Thus, even if it does not take out a micro sample within equipment, most appearances of a micro sample are included in the sample production equipment which also shows the equipment processed by the ion beam to this application. Moreover, hole processing is carried out by FIB not only at the sample production equipment which takes out the micro sample for analysis from a wafer as mentioned above but at a wafer, the interior of a device, such as the cross-section section, is observed with the electron beam emitted from the electron beam irradiation equipment taken and hung by FIB or this equipment, and it contains in the sample production equipment which also shows the sample production equipment which carries out device analysis to this application.

[0059]

[Effect of the Invention] A new defect is not generated even if it returns to a process the wafer which did not consume an ingredient vainly because of assessment by using the inspection / analysis approach by this application, and started the sample for inspection. Moreover, by using the electronic-parts manufacture approach by this application, it can evaluate without ****(ing) a wafer, a new defect is not generated, and an expensive wafer is not made useless. As a result, the manufacture yield of electronic parts improves. Furthermore, the sample production equipment which can realize these inspection / analysis approaches and the electronic-parts manufacture approach is offered.

[Brief Description of the Drawings]

[Drawing 1] Drawing for explaining the flow of the wafer in the process in connection with the electronic-parts manufacture approach by this application.

[Drawing 2] Drawing for explaining the flow which separates a minute sample from the conventional sample.

[Drawing 3] Drawing showing the example of 1 operation gestalt of the sample production equipment by this application.

[Drawing 4] Drawing showing the example of 1 operation gestalt of the sample production equipment by this application.

[Drawing 5] Drawing showing the example of 1 operation gestalt of the sample production equipment by this application.

[Drawing 6] Drawing for explaining the sample production procedure in connection with the electronic-parts manufacture approach by this application.

[Drawing 7] Drawing for explaining the sample production approach in connection with the electronic-parts manufacture approach by this application.

[Description of Notations]

1 [-- The source of a depository, 5 / -- MADEPOGASU,] -- FIB, 2 -- A sample, 3 -- A probe, 4 6 -- A micro sample, the 11--Nth processes, the 12--N+1st processes, 13 [-- Sample production equipment,] -- A lot, 14 -- A checking wafer, 15 -- An inspection electron microscope, 17 18 -- Analysis equipment, 31 -- An ion beam lens, 32 -- Liquid metal ion source, 33 -- Beam limit aperture, 34 -- An ion-beam-scanning electrode, 35 -- FIB exposure optical system, 38 [-- Sample stage,] -- An aggregated particle detector, 37 -- The source of a depository, 38 -- A sample substrate, 39 41 [-- Laser generating oscillator,] -- A vacuum housing, 42 -- A manipulator, 40 -- A sample holder, 51 52 -- Laser amplifier, 54 -- A laser reflecting mirror, 55 -- Laser beam study lens, 56 -- A laser generator, 61 -- A stage control unit, 62 -- Manipulator control unit, 63 -- An amplifier, 64 -- The source control unit of DEPOGASU, 65 -- FIB control unit, 71 -- A laser reflecting mirror control unit, 72 -- The source control unit of laser optics, 73 -- Laser device control unit, 74 -- Computation

equipment, 81 -- A duo plasmatron, 82 -- Ion beam lens, 83 -- Beam limit aperture, 84 -- An ion-beam-scanning electrode, 91 -- Duo-plasmatron control unit, 92 -- An ion beam lens control device, 93 -- Ion-beam-scanning control device, 201 [-- Holder cassette,] -- A silicon wafer, 202 -- A thin film, 76 -- A sample holder, 77 78 [-- Wiring of Cu, 205 / -- A circle, 206 / -- A deposit, 207 / -- A sample thin film, 208 / -- A thin film, 209 / -- TEM sample holder.] -- A migration means, 80 -- A stage control unit, 203 -- Silicon oxide, 204